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# Dung preference of the dung beetle *Scarabaeus cristatus* Fab (Coleoptera-Scarabaeidae) from Kuwait

Wasmia Al-Houty & Faten Al-Musalam

*Department of Zoology — Faculty of Science, Kuwait University, P.O. Box 5969 Safat, 13060, Kuwait*

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Adult dung beetles, *Scarabaeus cristatus*, consume the fluid components of dung and bury whole dung as food for their larvae. When dung from three herbivorous animals, horse, camel and sheep, was offered, the beetles preferred the more fluid horse dung to the others. Sheep dung was preferred to the camel dung. The dung of two carnivores, dog and fox, was also accepted but to a lesser extent than the herbivore dung.



**Keywords:** dung; dung beetle; *Scarabaeus cristatus*; Kuwait

## Introduction

Animal droppings form a microhabitat that is generally of high nutritional quality and there are major differences between the dungs of herbivores and carnivores (Hanski, 1991).

The dung of herbivorous animals varies in the concentration of nutrients, in moisture content and in consistency (Hanski, 1987). It generally consists of two components, the relatively low quality remains of undigested plant material and a high quality component derived from the micro-organisms in the mammalian gut and their products. The vegetation upon which an animal grazes affects the chemical composition of the dung. Green leaves of young grass plants are high in protein and low in cell wall materials, while leaves of woody plants contain more protein and less fibre than grass (Owen-Smith, 1982).

Adult scarab beetles feed on the fluid component of the dung while their larvae ingest whole dung (Miller, 1961; Dowding, 1967; Halffter, 1982; Hata & Edmonds, 1983). These beetles are desert scavengers that break up the dung of camels, goats and other animals (Abushama, 1984). Even though *Scarabaeus cristatus* Fab. is abundant in the desert of Kuwait during the warm season of spring and early summer, the preferences of this beetle for various types of animal dung have not yet been investigated. The present report deals with the food preferences of *S. cristatus* when supplied with dung of herbivorous and carnivorous animals.

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## Materials and methods

Most of the dung beetles, *S. cristatus*, used in this work were collected from a farm, about 65 km south of Kuwait town (28°38' N and 47°53' E). They were housed in wooden cages 100 cm long and 50 cm wide and with a door in the top. Each cage was divided into two parts. The upper 50 cm was covered by mesh to facilitate ventilation, and the lower 50 cm was covered by glass to accommodate sand and the dung beetles. Part of the mesh (an area of 225 $cm^2$) was replaced by a muslin sleeve for manipulation of beetles. Each cage had one or two cardboard partitions. Cages containing dung from three herbivores were divided into three portions, for dung of domestic horse, Arabian camel and domestic sheep (Fig. 1). Cages used for dung of carnivores were divided into two halves, one for dog dung and the other for Arabian fox dung. The cages were partitioned after they had been filled with freshly collected desert sand. Each cage accommodated ten beetles which were chosen randomly from the beetle breeding cage. Fresh pre-weighed dung was offered to the beetles every time the dung had been utilised or dried out. The experiments on herbivore and carnivore dungs were repeated five times.

Fresh dung was collected weekly from two sources: the horse, camel and sheep dung from AL-Atraf, about 48 km north-west of Kuwait (29°25' N and 47°30' E). Fox and dog dung were collected from the Kuwait Zoo in the central part of the State of Kuwait.

The water content of each dung was determined by oven-drying ten samples to constant masses at 105°C (Stevenson & Dindal, 1987). The total nitrogen content of the dung was determined by Kjeldahl analysis (Williams, 1984).

Data were transformed to arcsine which were then statistically analysed by a one-way ANOVA. The *F*-test was used for the herbivorous dungs while *t*-test was used for the carnivorous dungs to obtain the significance levels.

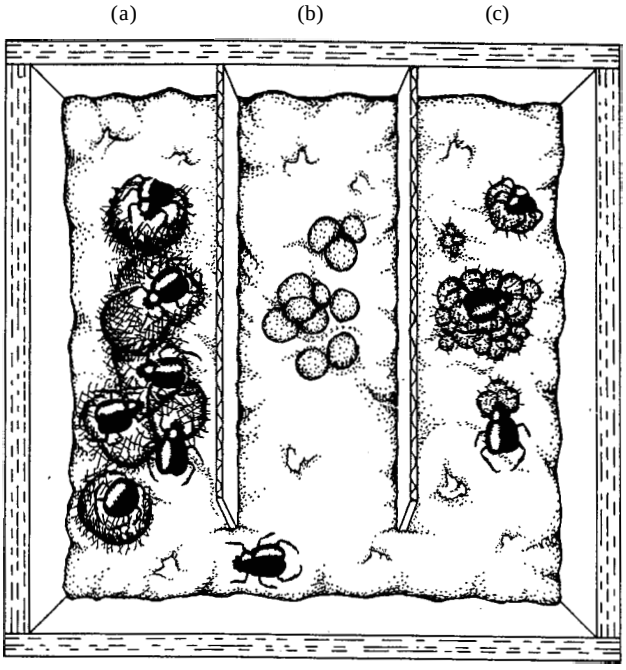


**Figure 1.** Diagram showing the cage partitions in the dung preference experiment: (a) horse dung, (b) camel dung, (c) sheep dung.

Behavioural patterns, including shredding of collected dung pads, rolling and burying time, were recorded. Daily observations included weighing the remaining dung to determine the amounts utilised, measuring the sites of the nest built, and recording the depth of the nesting holes. These records and observations were continued until the dung dried out or the beetles stopped utilising it.

To observe the number of times each beetle visited the dung, each beetle was marked with a different coloured thread tied firmly around the hind legs.

## Results

Table 1 shows the mean amounts of dung offered to the beetles from the three herbivores and the mean amounts and percentages utilised during the experiment. One-way analysis of variance for the arcsine transformed data showed that the differences between the amount of herbivorous dung consumed on the first, second and third days were significant at the 5% level. The mean amounts of dung consumed in 3 days differed significantly between the three herbivores at the 5% level, especially between the camel and horse dung and between the camel and sheep dung, when using the least square differences test.

Table 2 gives the mean amounts of dung of the two carnivores offered, and the mean amounts and percentages consumed during the experiment. As only two samples were available, the *t*-test was used for statistical analysis. The *t*-test for the arcsine transformed data showed that the amount of carnivorous dung consumed on the first, second and third days did not differ significantly between dog and fox ($p > 0{\cdot}2$).

Table 3 indicates the mean percentage content of water and total nitrogen in the dung used in the experiment. Horse dung had the highest water content while the dog dung had the lowest. Fox dung had the highest nitrogen content whereas the sheep dung had the lowest.

After making the dung balls, which differed in weight according to the dung type (38·1 g, 17·8 g and 16·0 g for horse, sheep and camel, respectively), *S. cristatus* rolled these balls between their hind legs over various distances (ranging from 19, 22 and 24 cm for horse, sheep and camel dung, respectively) before they pulled them into their feeding and breeding burrow. The burrow had an ovoid entrance and an oblique tunnel that reached an average length of 2–9 cm depending on dung type used. Some individuals made a hill of excavated soil to hide the nest entrance.

## Discussion

Due to the scarcity of vertebrate dung in the desert and the high rate of desiccation (Schoenly, 1983), desert dung beetles may be adapted to use any available dung.

*Scarabaeus cristatus* is able to utilise any kind of mammalian dung deposited in the desert of Kuwait (Al-Houty & Al-Musalam, 1996) but with some degree of preference. They prefer dung that is easy to manipulate and roll, and hence semi-solid dung is preferable to semi-liquid forms. The mean weight of *S. cristatus* is 1·2 g and the mean weight of a ball of herbivore dung is 24·0 g, so the ratio of the weight of the ball to the weight of the beetle is 1:20. This weight can be compared to that for *S. sacer* where the mean body weight is 2·0 g and the mean weight of a ball of dung is 30·0 g, ratio 1:15 (Hanski & Combefort, 1991).

*Scarabaeus cristatus* took 5–10 min to make dung balls. Hanski & Combefort (1991) suggested that the faster a beetle is in making and rolling balls, the worse it is at digging burrows. *Scarabaeus cristatus* was observed to be fast at making a ball, as it is a nocturnal dung beetle which usually works swiftly. Bartholomew & Heinrich (1978) recorded that *S. laevistriatus*, another ball-rolling beetle active at night, works with an

**Table 1.** *Mean utilisation (g) of herbivore dung offered to ten beetles,* Scarabaeus cristatus, *for 3 days*

| Source of dung | Initial wt. of dung | Mean amount of dung utilised in | | | Mean percentage of dung utilised in | | |
|---|---|---|---|---|---|---|---|
| | | 1 day | 2 days | 3 days | 1 day | 2 days | 3 days |
| Horse | 245·4±25·3 | 235·8±27·3 | 241·2±25·0 | 241·2±25·0 | 95·8±2·7 | 98·4±1·6 | 98·4±1·6 |
| Camel | 233·8±23·7 | 60·7±38·6 | 60·7±38·6 | 60·7±38·6 | 26·5±16·5 | 26·5±16·5 | 26·5±16·5 |
| Sheep | 227·0±27·6 | 162·2±9·2 | 178·4±13·9 | 178·4±13·9 | 68·0±5·5 | 74·5±6·6 | 74·5±6·6 |

$F_{2,12}=3\times10^{-4}$, $p<0{\cdot}01$ for the amount of herbivorous dung utilised in 1 day.
$F_{2,12}=1\times10^{-4}$, $p<0{\cdot}01$ for the amount of herbivorous dung utilised in 2 and 3 days.

**Table 2.** *Mean utilisation (g) of carnivore dung offered to ten beetles,* Scarabacus cristatus, *for 3 days*

| Source of dung | Initial wt. of dung | Mean amount of dung utilised in | | | Mean percentage of dung utilised in | | |
|---|---|---|---|---|---|---|---|
| | | 1 day | 2 days | 3 days | 1 day | 2 days | 3 days |
| Dog | 228.8±25.0 | 173.8±23.2 | 186.0±24.2 | 186.0±24.2 | 78.7±10.1 | 84.4±10.9 | 84.4±10.9 |
| Fox | 160.0±4.6 | 12.2±5.5 | 13.4±5.3 | 13.4±5.3 | 68.3±10.2 | 79.4±13.0 | 79.4±13.0 |

For the above data $t_8=0{\cdot}6$; $p>0{\cdot}2$ for the amount of carnivorous dung utilised in 1 day; and $t_8=1{\cdot}0$; $p>0{\cdot}2$ for the amount of carnivorous dung utilised in 2 and 3 days.

**Table 3.** *Mean percentages of water and total nitrogen in the dung used*

| Animal dung | Water content | Nitrogen content |
|---|---|---|
| Horse | 73 | 3·4 |
| Sheep | 70 | 1·8 |
| Camel | 62 | 2·2 |
| Fox | 54 | 4·2 |
| Dog | 27 | 3·4 |

almost frenzied haste and often forms a dung ball and rolls it away in less than 2 min, while the diurnal ball-rolling *Kheper* beetle usually requires 10–30 min to make its dung ball.

Adult dung beetles feed on the fluid component of the dung (Halffter & Matthews, 1966), and more fluid could be ingested from the horse dung than from the camel dung as the water content of the former was 73% while the latter was 62% (Table 3). The preference for horse dung can be attributed to other reasons beside the high water content; horse dung is always full of seeds that the large beetle can potentially bury (Janzen, 1982).

Dung of lower moisture content is unsuitable for the beetles. They failed to roll the fox dung, but shredded this source of food into small fragments and mixed it with soil before burying it for future consumption by their offspring. Dog dung was remarkably dry, though it did not contain bone or hair, but when offered as the sole source of nutrient the beetles could still utilise it (Al-Houty & Al-Musalam, 1996).

Donovan (1979) found that the order of decreasing preference of dung beetles, *Onthophagus* spp., for herbivorous dung was horse, sheep, cattle and finally kangaroo. Davis (1989) showed that the number of brood balls produced per chamber by *Oniticellus egregius* is several times greater when using horse dung than cattle dung.

*Scarabaeus cristatus* is normally more abundant on farms than in towns; on farms the horses and sheep usually graze and hence provide dung for this night-foraging dung beetle. Sheep and camels are also seen ranging on desert vegetation and their droppings are available for this beetle as well.

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